# SYSTEM FOR TREATING, IN PARTICULAR FOR CATAPHORETICALLY DIP-COATING VEHICLE BODIES

The invention relates to a system for treating, in particular for cataphoretically dip-coating, articles, in particular vehicle bodies, comprising

a) at least one bath, in which a treatment liquid is situated, into which the articles are to be dipped;

b) a feed device, by means of which the articles are conveyed through the system and in the process are dipped into the at least one bath;

c) a dripping zone, which is disposed in the direction of motion downstream of the last bath;

d) a tilting apparatus within the dripping zone, in which apparatus the articles may be tilted into an angular position relative to the horizontal that is suitable for dripping-off;

e) a drier situated downstream of the dripping zone.

Vehicle bodies or other articles leaving the last rinsing bath or the last spraying zone of a cataphoretic dip-coating system have to drip off well prior to entry into the drier, wherein at the same time flashing-off occurs. In said case, it is necessary to avoid the formation on the articles of fat edges, so-called "runs", which after drying in the downstream drier are removable only by laborious grinding operations. In known systems of the initially described type, the feed device is changed downstream of the last bath of the cataphoretic dip-coating zone. For

example, the vehicle bodies, which are conveyed with the aid of a shuttle conveyor through the various baths and are themselves carried by skids, are deposited in the dripping zone onto a roller conveyor. This roller conveyor, because of the extremely contaminating effect of the liquid entrained from the bath, has to be made substantially of special steel.

To enable efficient draining of the liquid off the vehicle bodies and in particular out of their cavities, in the known coating systems a separate tilting apparatus is provided within the dripping zone. The vehicle bodies have to be transferred from the roller conveyor onto this tilting apparatus, where they are brought into a tilted position relative to the horizontal, then swivelled back into the horizontal and transferred back to the roller conveyor system. The equipment outlay for this is high. Furthermore, given a fast cycle time of the coating system, the respective vehicle body situated in the tilting apparatus may be swivelled out of the horizontal for dripping-off only for a relatively short time. In many cases, therefore, the dripping-off operation may not be completed inside the tilting apparatus, the result being that fat edges may form on the surfaces of the vehicle body.

A further drawback of the known system is that with the aid of the tilting apparatus generally only a single angular position of the vehicle body relative to the horizontal may be achieved. It is however often not guaranteed that in this single angular position the entrained liquid may reliably run out of all of the cavities of the vehicle body.

The object of the present invention is to develop a system of the initially described type in such a way that it involves only a low equipment outlay and yet achieves a better result in the dripping zone.

This object is achieved according to the invention in that

f) the feed device comprises at least one feed carriage, which in turn comprises:

fa) running gear movable along the path of motion of the articles;

fb) at least one swivel arm coupled to the running gear;

fc) a holding device coupled to the swivel arm for at least one article;

fd) mutually independently actuable drives for the translational movement, the swivelling motion of the at least one swivel arm and of the holding device;

g) the at least one feed carriage simultaneously serves as a tilting apparatus and for said purpose is movable over the dripping zone to a point in the vicinity of the drier.

The feed carriage utilized by the present invention is known in principle from DE-U-201 05 676. There, however, it is used only for dipping the articles to be treated into

and out of a bath. The present invention recognizes that this feed carriage, owing to its style of construction, is suitable not only as an apparatus for dipping articles into and out of baths but also as a tilting apparatus in the dripping zone owing to the possibility of bringing the fed articles into any desired angular position. The running surfaces, along which the feed carriage travels, therefore need merely be extended beyond the zone of the treatment baths and across the dripping zone. A transfer of the articles onto a separate feed device within the dripping zone is therefore unnecessary, as is locking on a separate tilting apparatus and unlocking for further conveying, as was required in the background art.

In contrast to the background art, with the present invention dripping-off in a tilted position relative to the horizontal may occur also while the feed carriage is moving. The dripping-off time may therefore be extended compared to the dripping-off time in known systems. If different articles are treated in succession, the angular position relative to the horizontal that is suitable for dripping-off may be selected for each article.

A further big advantage of the use of such feed carriages is that by means of a suitable inclination of the vehicle bodies already over the last bath a very extensive dripping-off may be achieved and, for this reason alone, the entrainment of bath liquid is substantially reduced compared to the background art. On the whole, with the system according to the invention, dripping-off may be completed in an optimum manner before the articles enter the drier, thereby substantially avoiding the formation of

fat edges, which would necessitate laborious after-treatment.

Particularly preferred is the embodiment of the invention, in which the at least one feed carriage is controllable in such a way that its holding device is brought within the dripping zone into at least two positions, in which it is tilted differently relative to the horizontal. This development takes account of the experience that for articles of a complicated shape containing cavities it is often impossible to find a (single) angular position relative to the horizontal that allows efficient draining and/or dripping of the liquid from all points and from all cavities.

There now follows a detailed description of an embodiment of the invention with reference to the drawings; the drawings show:

Figure 1: a side view of a feed carriage, which is used in the coating system, with a vehicle body fastened thereto in normal feed position;

Figure 2: a side view of the feed carriage similar to Figure 1, in which however the vehicle body is swivelled out of the feed position;

Figure 3: the plan view of the feed carriage of Figure 2;

Figure 4: a perspective view of the feed carriage plus vehicle body of Figure 1;

Figure 5: a section through Figure 3 according to the line VIII-VIII of Figure 3;

Figures 6 and 7: enlarged detail views of the feed carriage in the region of the wheels positioned on running surfaces;

Figure 8: a diagrammatic view of the transition region of the coating system between the last spraying/immersion container and the cataphoretic dip-coating drier.

First, there now follows a detailed description with reference to Figures 1 to 7 of the style of construction of feed carriages 5 of the type used in the coating system illustrated in the further drawings. Such feed carriages 5 are admittedly known in principle from DE-U-201 05 676, to which reference is additionally made. However, since a knowledge of the kinematics of these feed carriages 5 is a prerequisite to an understanding of the overall system, the explanation of the feed carriages 5 is repeated to the necessary extent in the present description.

As Figures 3 and 4 in particular reveal, each feed carriage 5 has two longitudinal tie-bars 7, 8, at the underside of each of which two twin wheels 9, 10 and 11, 12 are mounted rotatably about a horizontal axis. The wheels 9 to 12 are additionally rotatable in each case with the aid of a not specifically illustrated swivelling bolster about a vertical axis, with the result that the alignment of the

twin wheels 9 to 12 relative to the respective longitudinal tie-bars 7, 8 may be varied.

The twin wheels 9, 10 roll along a first running surface 13 and the twin wheels 11, 12 roll along a second running surface 14 parallel to the first. The running surfaces 13, 14 are in turn mounted in each case on an I-beam 15, 16, which is supported by a non-illustrated steel structure.

In the middle of the, in Figures 3 and 4 right, second running surface 14 a guide rib 17 is provided, over which guide elements 18 having a complementary recess (cf. Figure 7) engage. In each case one guide element 18 is connected to the swivelling bolster of an associated twin wheel 11 and/or 12 in such a way that it rotates this twin wheel 11 and/or 12 about the vertical axis in accordance with the course of the guide rib 17. The twin wheels 11, 12 therefore follow the running surface 14. The twin wheels 9, 10 associated with the first, in Figures 3 and 4 left running surface 13, on the other hand, are designed purely as trailing wheels; in other words, no separate guide means are provided for influencing the angular position of the wheels about their vertical axis of rotation. In this way, the standards of accuracy demanded of the guide means that hold the feed carriages 5 on the running surfaces 13, 14 may be kept low.

Vehicle bodies 4 are carried on the feed carriages 5 with the aid of an immersion apparatus, which comprises one swivelling apparatus on each side of the vehicle bodies 4. Each of these swivelling apparatuses has a swivel arm 50, 51, which in a manner yet to be described may swivel in a vertical plane extending parallel to the feed direction.

For this purpose, each swivel arm 50, 51 is connected by a stub shaft 52, 53, which extends at right angles to the feed direction, to the output shaft of a gear unit 54, 55. The gear unit 54, 55 is fastened to the respective longitudinal tie-bar 7, 8 of the feed carriage 5 approximately in the central region thereof. It is driven by a motor 56 and/or 57, which is flange-mounted laterally on the gear unit 54, 55.

The, in direction of motion, rear ends of the swivel arms 50, 51 are hinge-connected to a link 58, 59, which in the normal feed position shown in Figure 1 extends vertically downwards from the corresponding swivel arm 50, 51. The bottom ends of the links 58, 59 are connected to one another by a transverse tie-bar 60, which extends at right angles to the direction of motion and is in turn connected rigidly to the central region of a support platform 61 for the vehicle body 4. The direction of extension of the two links 58, 59 in said case runs at right angles to the plane of the support platform 61.

The angular position that the links 58, 59 occupy relative to the swivel arms 50, 51 is determined in each case by an adjusting device, which as a whole bears the reference character 62 and/or 63. Each of these adjusting devices 62, 63 comprises a linkage having two parallel push rods 64, 65 and/or 66, 67, which at their opposite ends are connected to one another in each case by a connecting strap 68, 69 and/or 70, 71. The, in direction of motion, rear connecting straps 69 and/or 71 are fastened at their bottom end rigidly to the transverse tie-rod 60.

The, in direction of motion, front connecting straps 70, 71, on the other hand, are each connected rigidly to a stub shaft, which is not visible in the drawings because it extends coaxially through the associated stub shaft 52, 53 designed as a hollow shaft. These further stub shafts extend also through the gear units 54, 55 and are coupled to the output shafts of further gear units 78, 79, which are fastened laterally to the gear units 54, 55. Drive motors 80, 81 are also flange-mounted laterally onto the gear units 78, 79.

The front ends of the two swivel arms 50, 51 jointly carry a counterweight 88, so that the torques acting upon the stub shafts 52, 53 are approximately counterbalanced when a vehicle body 4 is placed on.

The twin wheels 19 to 12 of the feed carriages 5 are not themselves driven. Rather, forward propulsion of the feed carriages 5 is effected by means of a separate drive, which is described in detail below with reference to Figures 3 to 7.

Extending parallel to the two running surfaces 13, 14 are two vertically aligned, stationary driving flanges 26, 27. These interact in each case with a press roller drive 28, 29, which is fastened to the lateral surface of the adjacent longitudinal tie-bar 7, 8 by means of a link 30, 31. The press roller drives 28, 29 each comprise an electric drive motor 32, 33 and a drive gear unit 34, 35. The latter drives the parallel, vertical axles of two press rollers 36, 37 and/or 38, 39, which are pressed from both sides against the respective associated driving flange 26 and/or 27. When the drive motors 32, 33 are energized, the

press rollers 36, 37 and/or 38, 39 run along the respective lateral surfaces of the driving flanges 26, 27 and, in so doing, move the feed carriage 5 forward along the running surfaces 13, 14.

Each feed carriage 5 comprises its own carriage controller, under the regime of which it executes both its translational movement along the running surfaces 13, 14 and the swivelling motions of the swivel arms 50, 51 and of the support platform 61.

In summary, the movement options of a vehicle body 4 carried on a feed carriage 5 may be described as follows:

The overall movement arises from a superposition of the linear translational movement of the feed carriage 5, a first swivelling motion that the swivel arms 50, 51 execute relative to the longitudinal tie-bars 7, 8 and is linked to a lifting and/or lowering of the vehicle body 4, and a second swivelling motion that the vehicle body 4 situated on the support platform 61 executes relative to the swivel arms 50, 51. All of these types of movement may be carried out completely independently of one another, thereby leading to practically any desired kinematics of the vehicle body 4. In the previously described embodiment of a feed carriage 5, the swivelling motion is transmitted to the support platform 61 from the motors 80, 81 by means of linkage-like adjusting devices 62, 62. Naturally, the adjusting devices may however be designed differently, e.g. they may comprise continuous metal belts as torque-transmitting elements.

Reference is now made to Figure 8, which shows the detail of a coating system that is of relevance in the present context. In this drawing, in order to illustrate the sequence of motion, a vehicle body 4 is shown at different points as well as at different levels and angles relative to the horizontal. This vehicle body 4 is to be imagined as being carried by a feed carriage 5. The feed carriage itself is not illustrated for the sake of clarity. That the vehicle body 4 may occupy the respective positions, and how it does so, is however plain from the previous description of the feed carriage 5.

The left region of Figure 8 shows the last treatment stage in the form of rinsing bath 100 of a cataphoretic dip-coating zone of the coating system, which includes, further to the left and adjoining the portion illustrated in Figure 8, further rinsing baths and/or spraying zones as well as a cataphoretic dip-coating bath. The vehicle body 4 moves on the feed carriage 5 "net" in Figure 8 from left to right. A "net movement" means that the feed carriage 5 on the whole moves from left to right, although this does not rule out temporary reversals of motion when this is necessary to achieve specific kinematics of the vehicle body 4. To cite an example: if a vehicle body 4 is to be lifted substantially vertically, the swivel arms 50, 51 of the feed carriage 5 are swivelled in a corresponding manner; the component of motion in horizontal direction that is linked to this swivelling motion of the vehicle body 4 is compensated by a corresponding movement of the feed carriage 5 in horizontal direction, which may also be counter to the "net feed direction".

The rinsing bath 100 of the catalytic dip-coating zone is adjoined by a dripping zone 101. The vehicle bodies 4 are moved also through this dripping zone 101 on the same feed carriage 5 as they travelled on through the cataphoretic dip-coating zone. Immediately after removal from the rinsing bath 100 the vehicle body 4, by virtue of suitable swivelling of the swivel arms 50, 51 and of the support platform 61, is inclined at such a steep angle that the leading body end points upwards and the tail of the body points downwards. In this position the liquid carried out of the rinsing bath 100 by the vehicle body 4 may run out and drip off and be collected in a trough 102 disposed on the floor of the dripping zone 101. The vehicle body 4 may be conveyed further in this "tilted" position by the feed carriage 5; i.e. the movement does not have to be interrupted for the dripping-off process.

In the course of travel of the feed carriage 5 through the dripping zone 101, the vehicle body 4 after a specific time is swivelled back into its normal, horizontal position, as is shown in Figure 8. This is followed, by means of a corresponding movement of the swivel arms 50, 51 and of the support platform 61, by a swivelling of the vehicle body 4 in the opposite direction, in which therefore the leading region of the vehicle body 4 points downwards, while the tail is raised. In this position, entrained liquid from the rinsing bath 100 may run out of cavities, from which the liquid could not escape in the initially adopted tilted position. Finally, in the dripping zone 101 the vehicle body 4 is returned to a horizontal position.

The dripping zone 101 is adjoined by a transfer device 103, the style of construction of which is not relevant in the

present context. This transfer device 103 removes the vehicle body 4 from the feed carriage 5, which is returned for loading with another vehicle body 4. The transfer device 103 then places the vehicle body 4 on a lifting apparatus 104 in the intake lock 105a of a conventional drier 105, such as is usually disposed downstream of the cataphoretic dip-coating zone of a coating system. Once again, the exact style of construction both of the lifting apparatus 104 and of the drier 105 is of no importance in the present context.